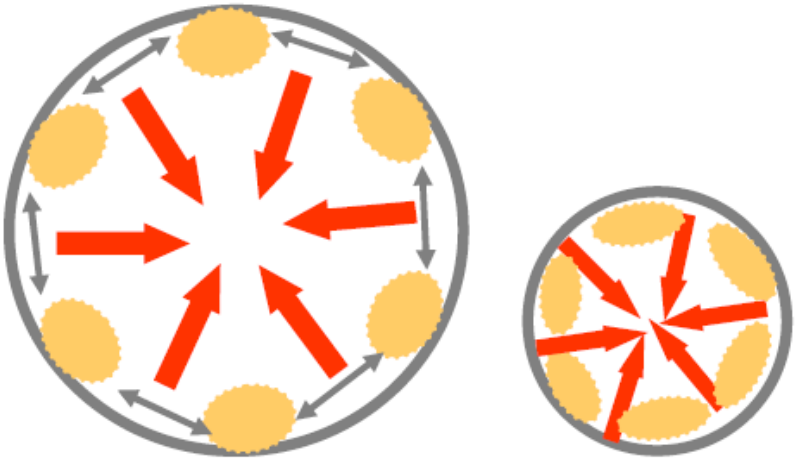
Airway Resistance

- Normally insignificant
- Mucus accumulation causes airway resistance to:
- Epinephrine causes:
  - Bronchiolar smooth muscle to:
  - Bronchiolar resistance to:
- Histamine causes bronchiolar smooth muscle to:
  - Bronchiolar smooth muscle to:
  - Bronchiolar resistance to:

Surface Tension

Surface Tension

- "Surface tension" tends to promote alveolar…
- *Why?*
- *Good thing or bad thing*
- *Remember surfactant?*



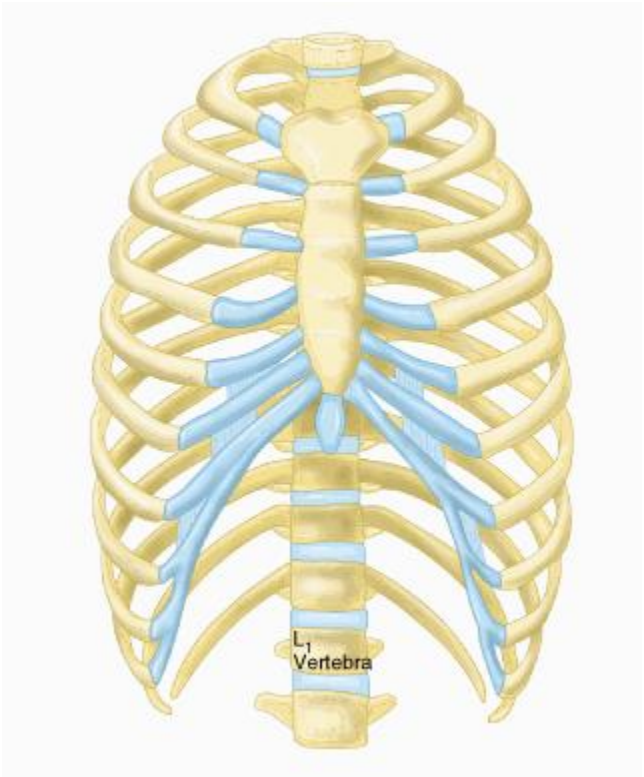
Surface Tension

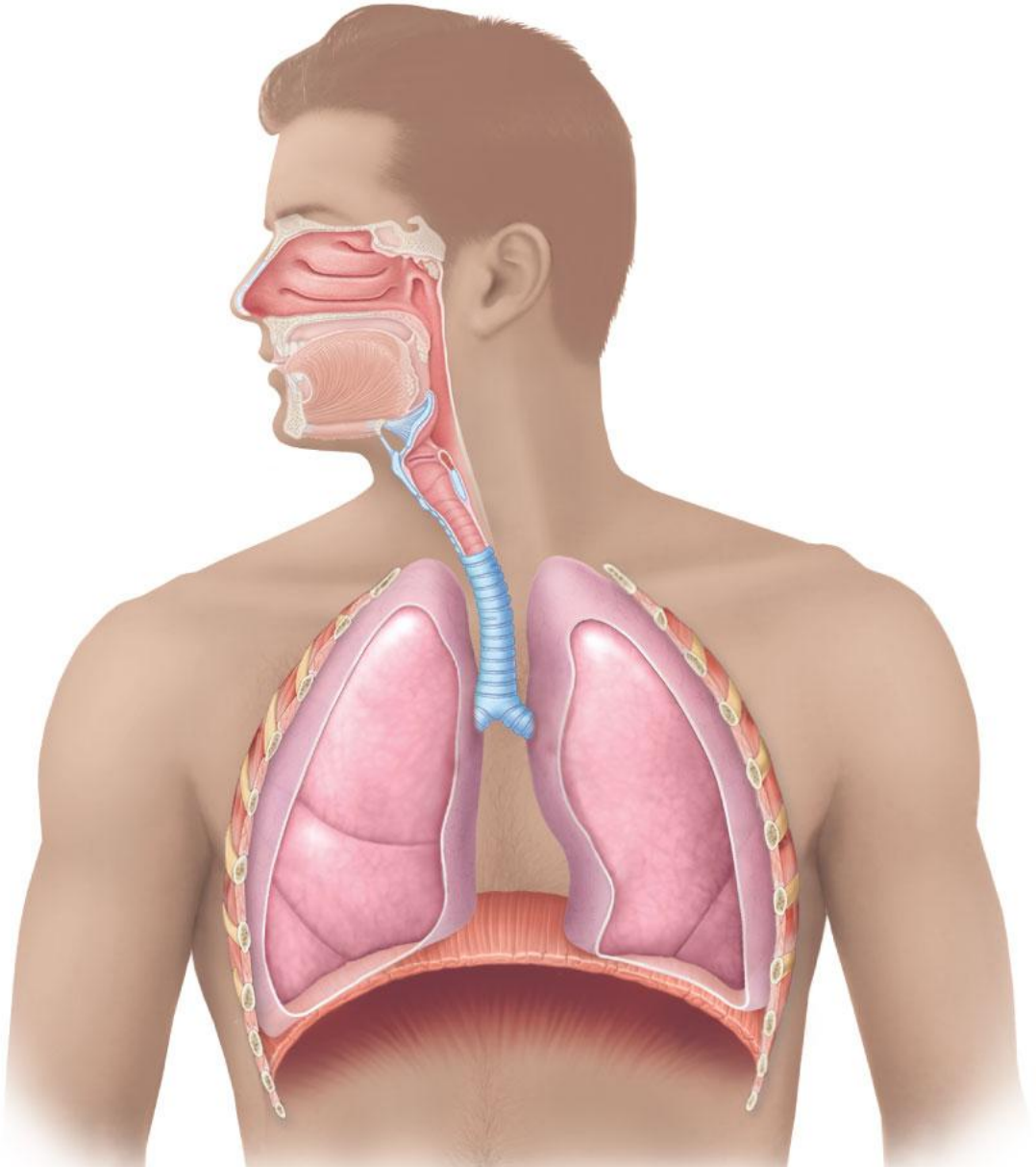
An autoimmune disease that caused destruction of type 2 alveolar cells would cause surfactant levels to…

This would cause alveolar surface tension to _____; and the amount of energy used to inflate the lungs would _____.

Compliance

- Lung Compliance
- Thoracic Compliance



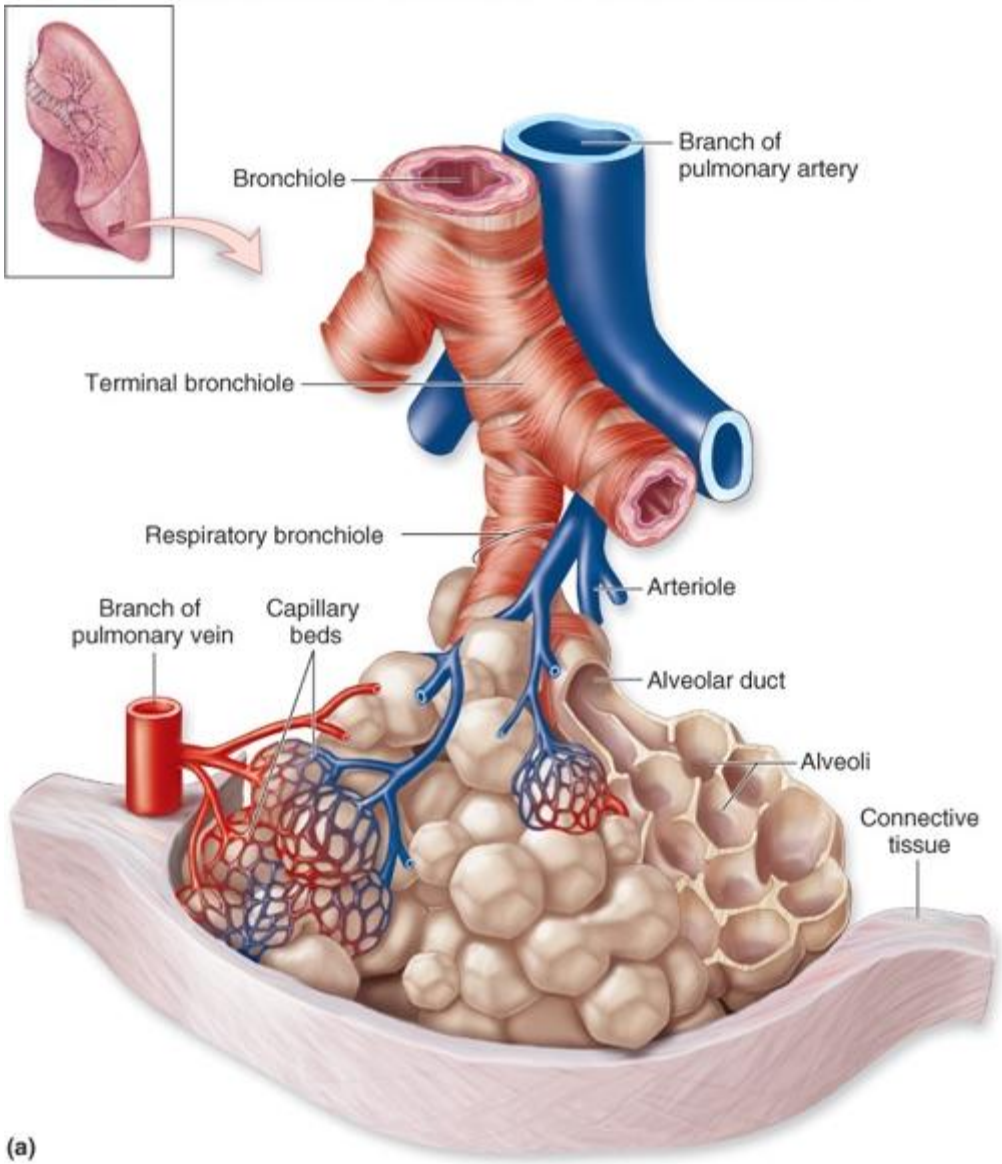


Atmospheric Composition

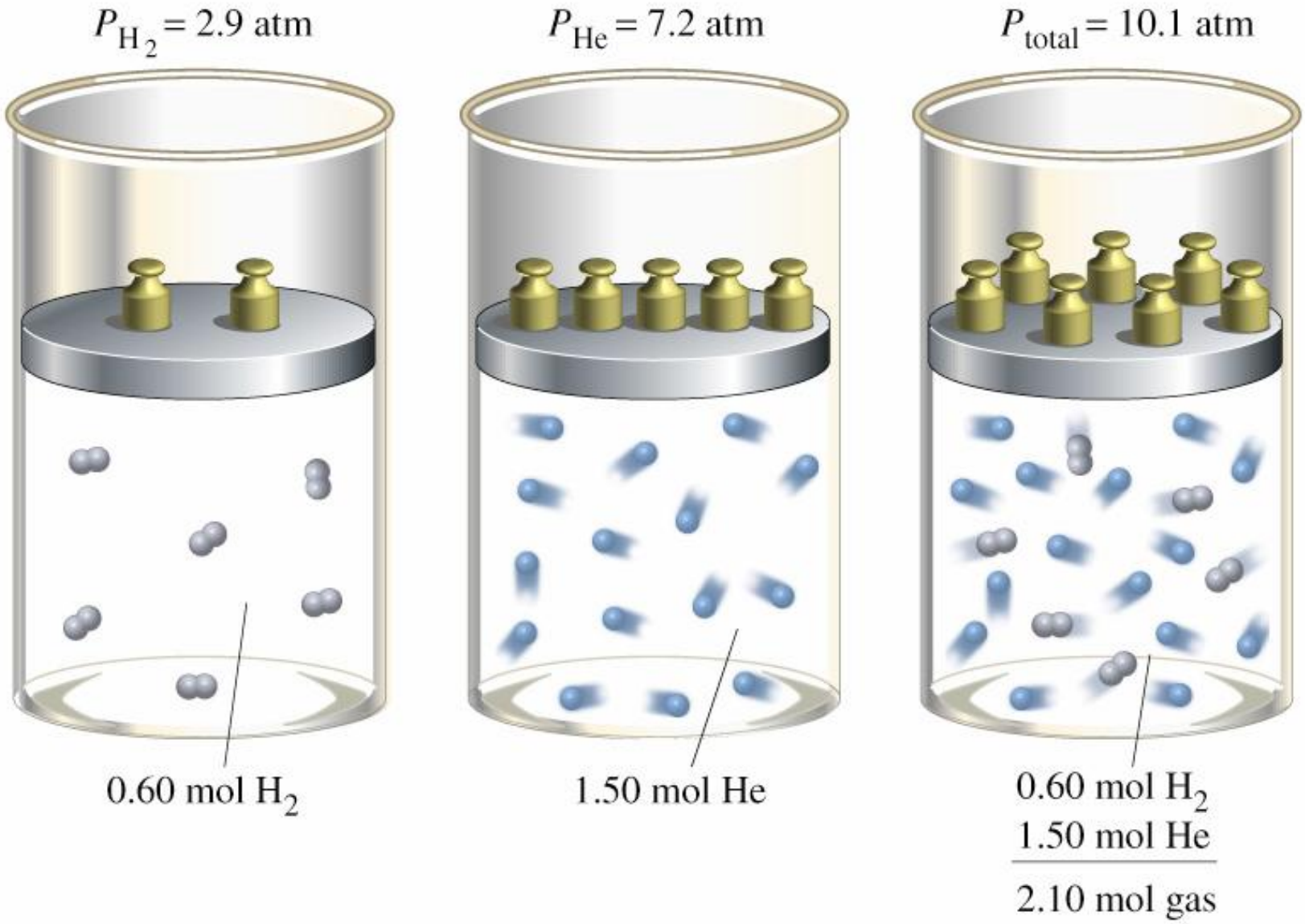
- CO_2 0.04%
- N_2 78.6%
- O_2 20.9%
- H_2O 0.46%

Alveolar Gas Composition

- CO_2 5.2%
- N_2 74.9%
- O_2 13.7%
- H_2O 6.2%

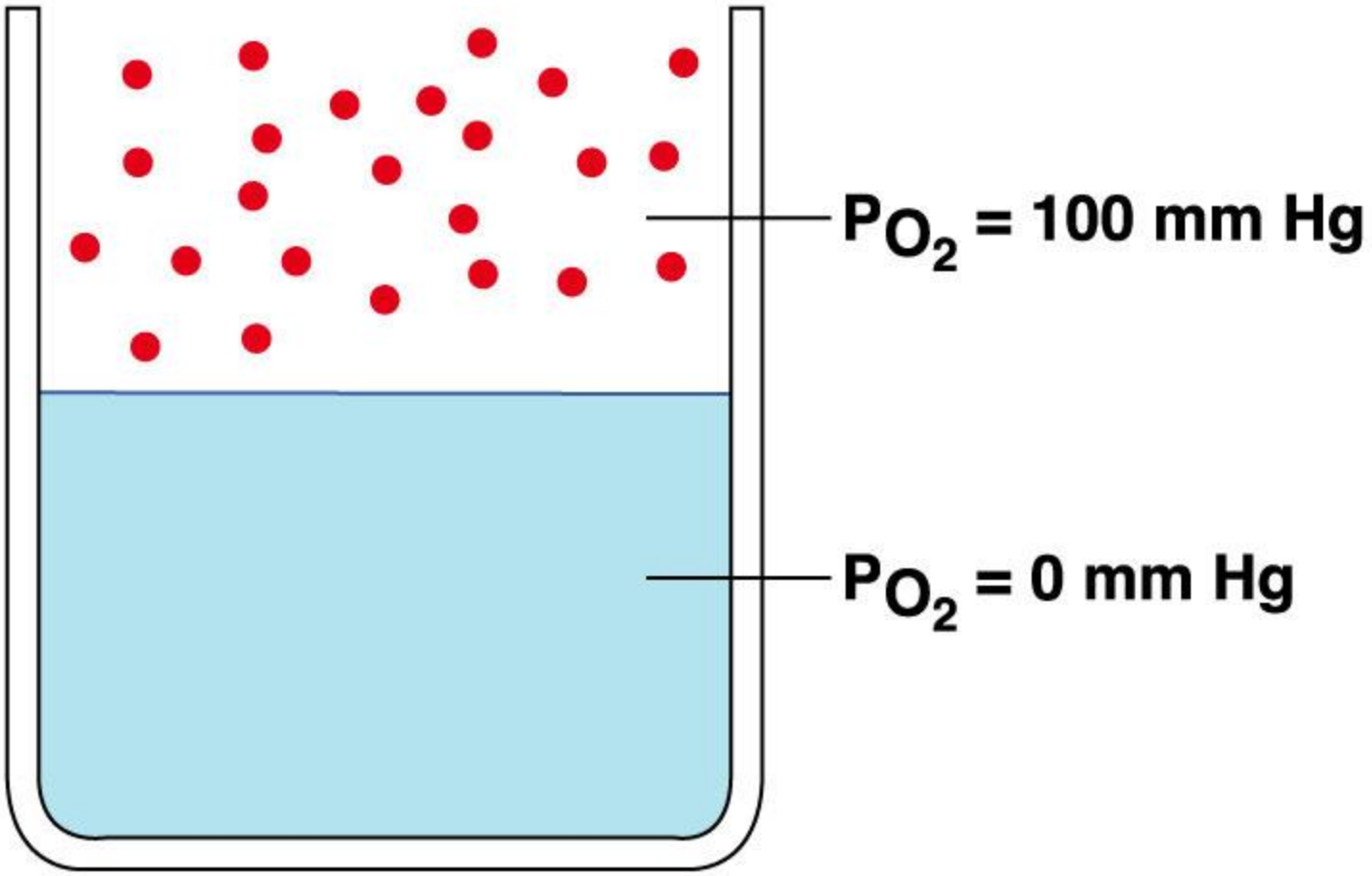


Dalton's Law of Partial Pressures

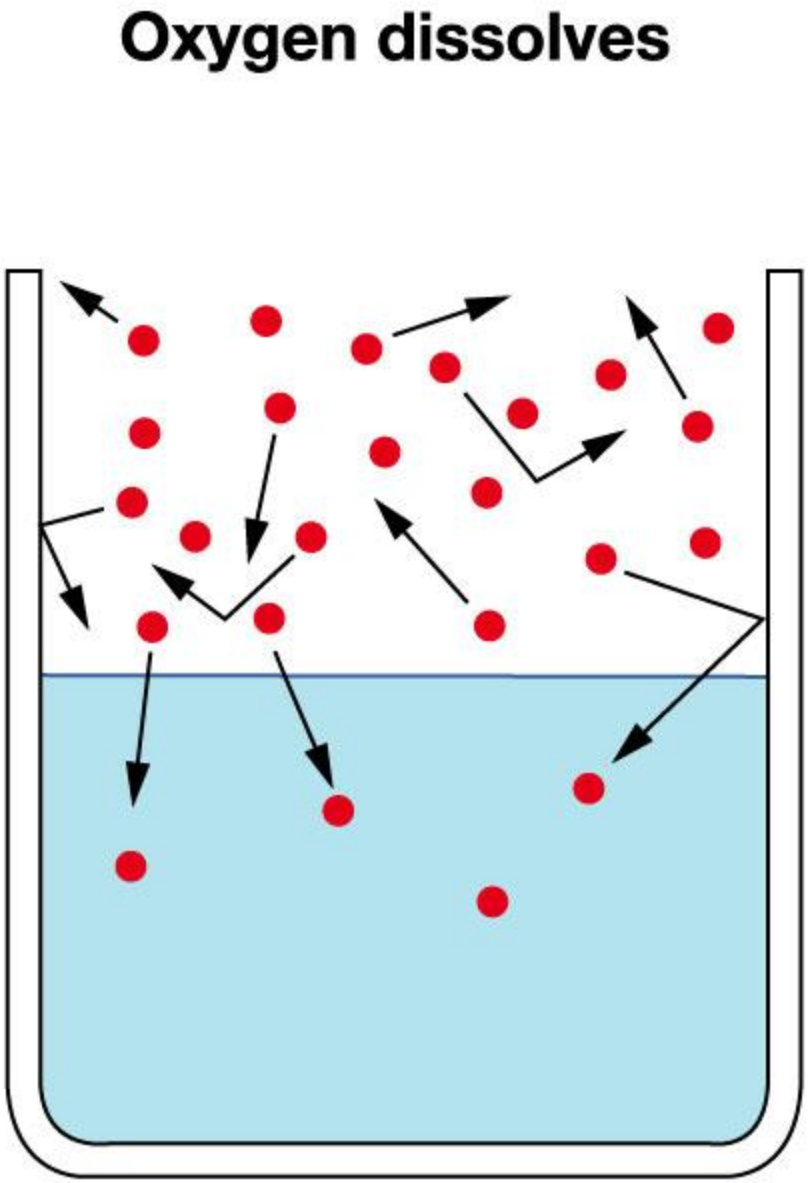


Henry's Law and Solubilities

Initial state:
no O_2 in solution

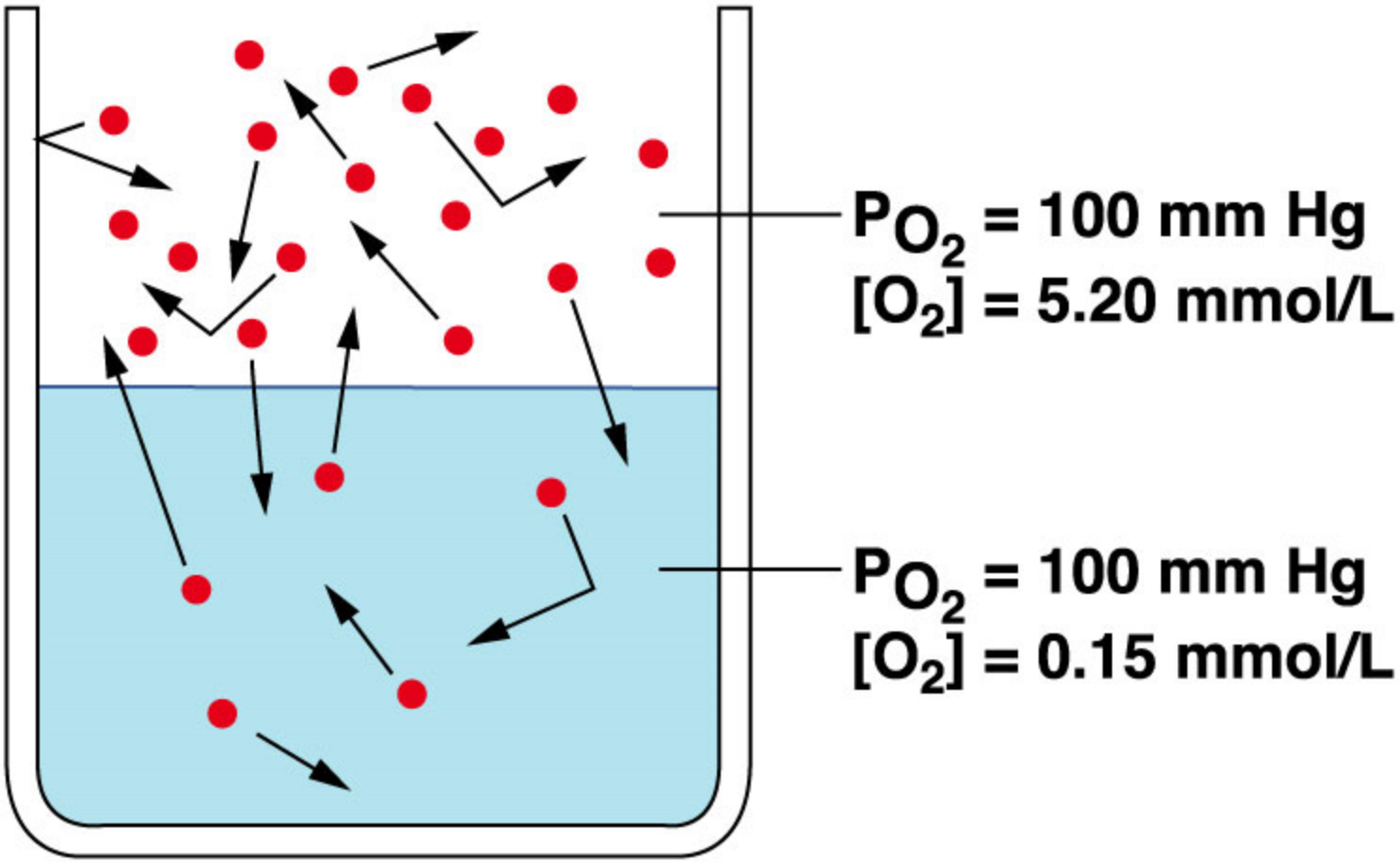


Henry's Law and Solubilities



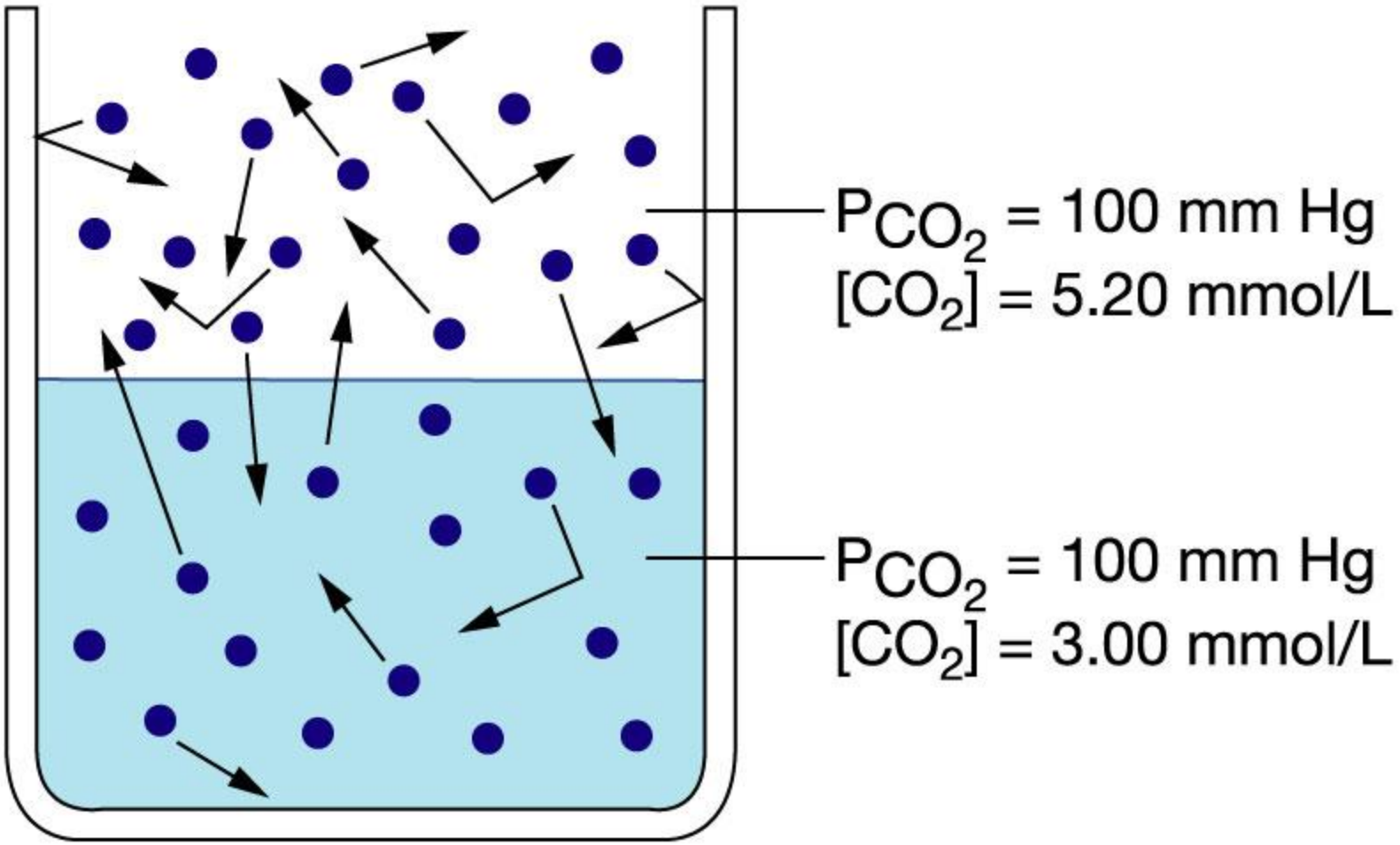
Henry's Law and Solubilities

At equilibrium, P_{O_2} in air and water is equal. Low O_2 solubility means concentrations are not equal.



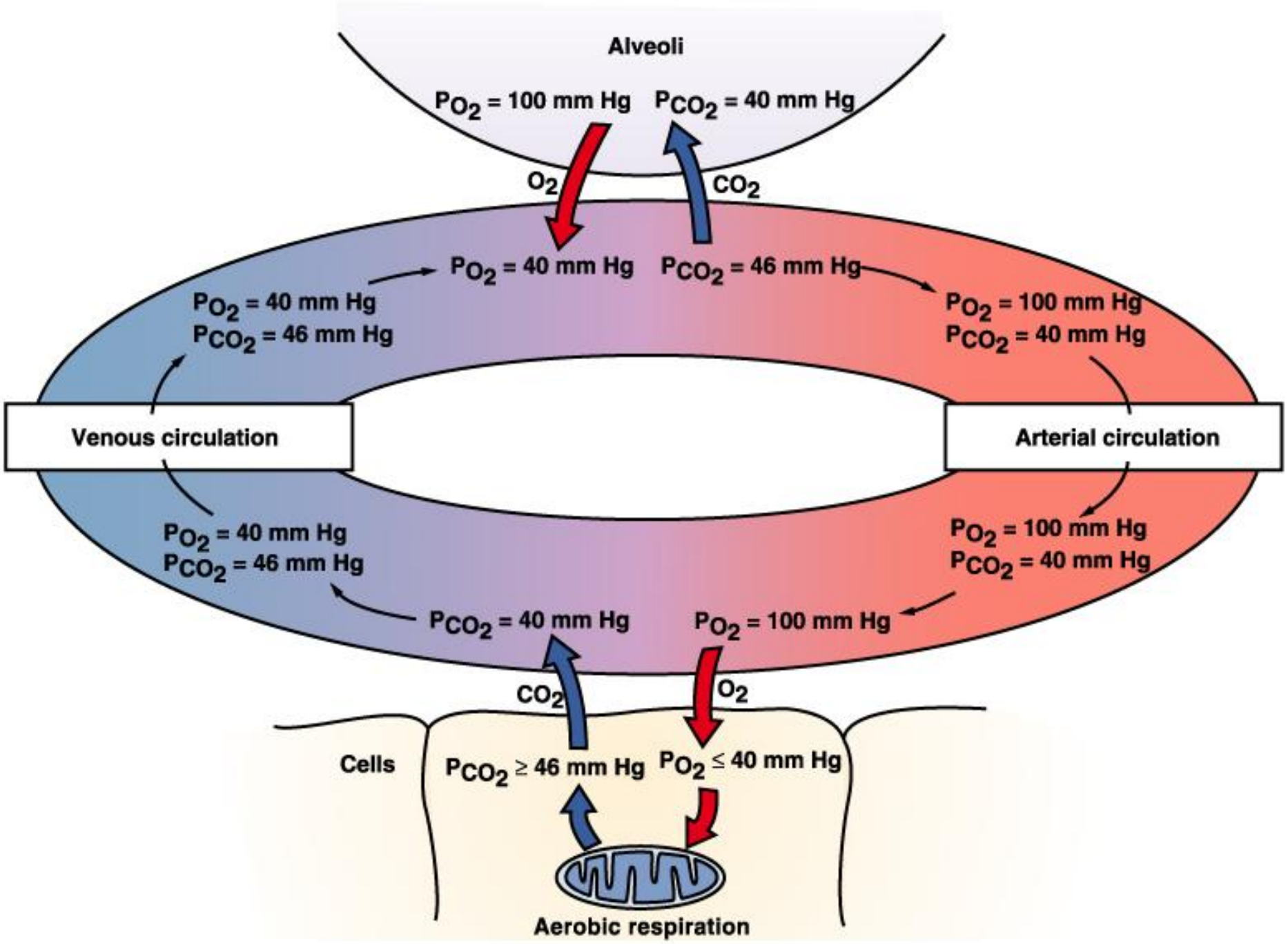
Henry's Law and Solubilities

When CO_2 is at equilibrium at the same partial pressure, more CO_2 dissolves.

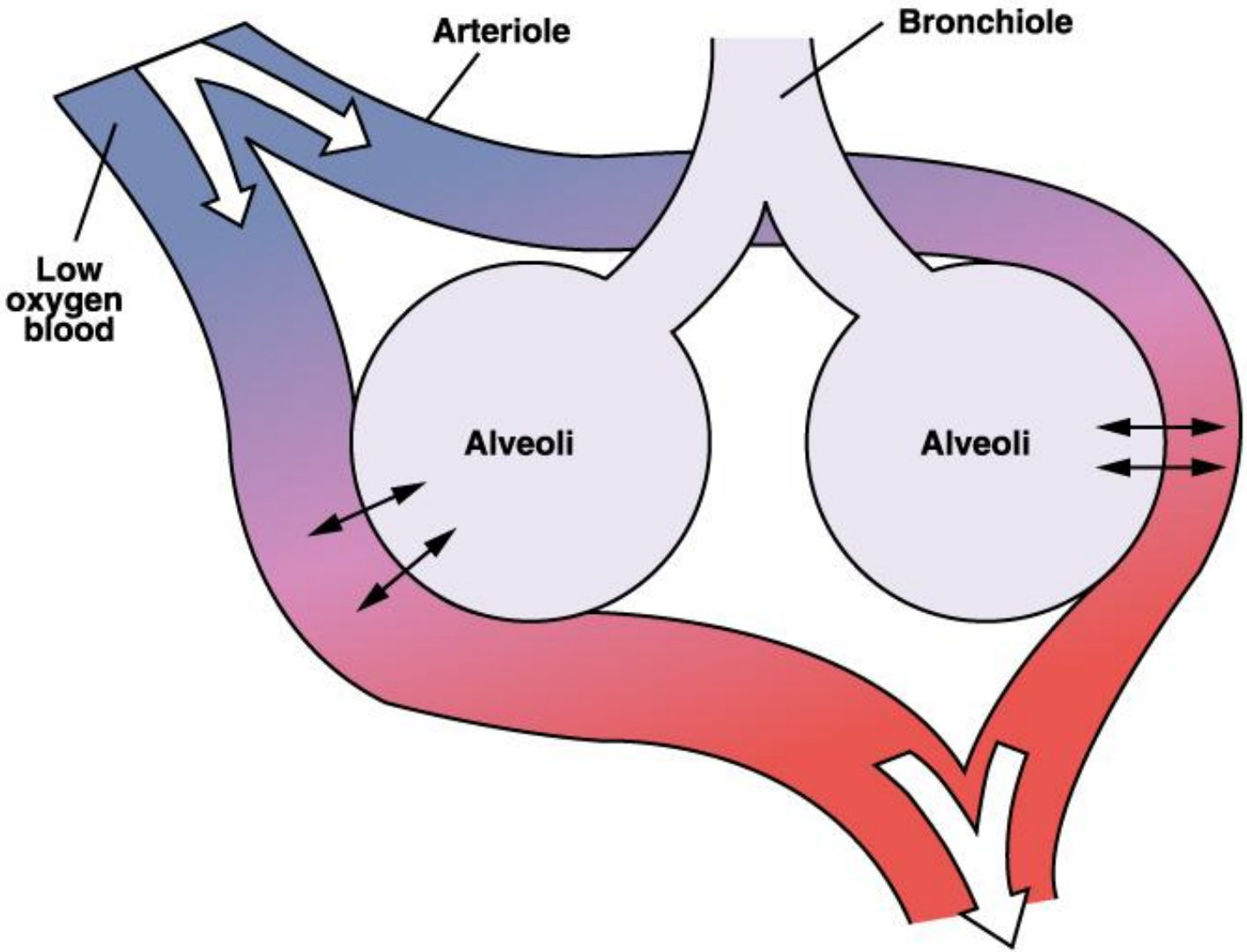


3 Factors Affecting External Respiration

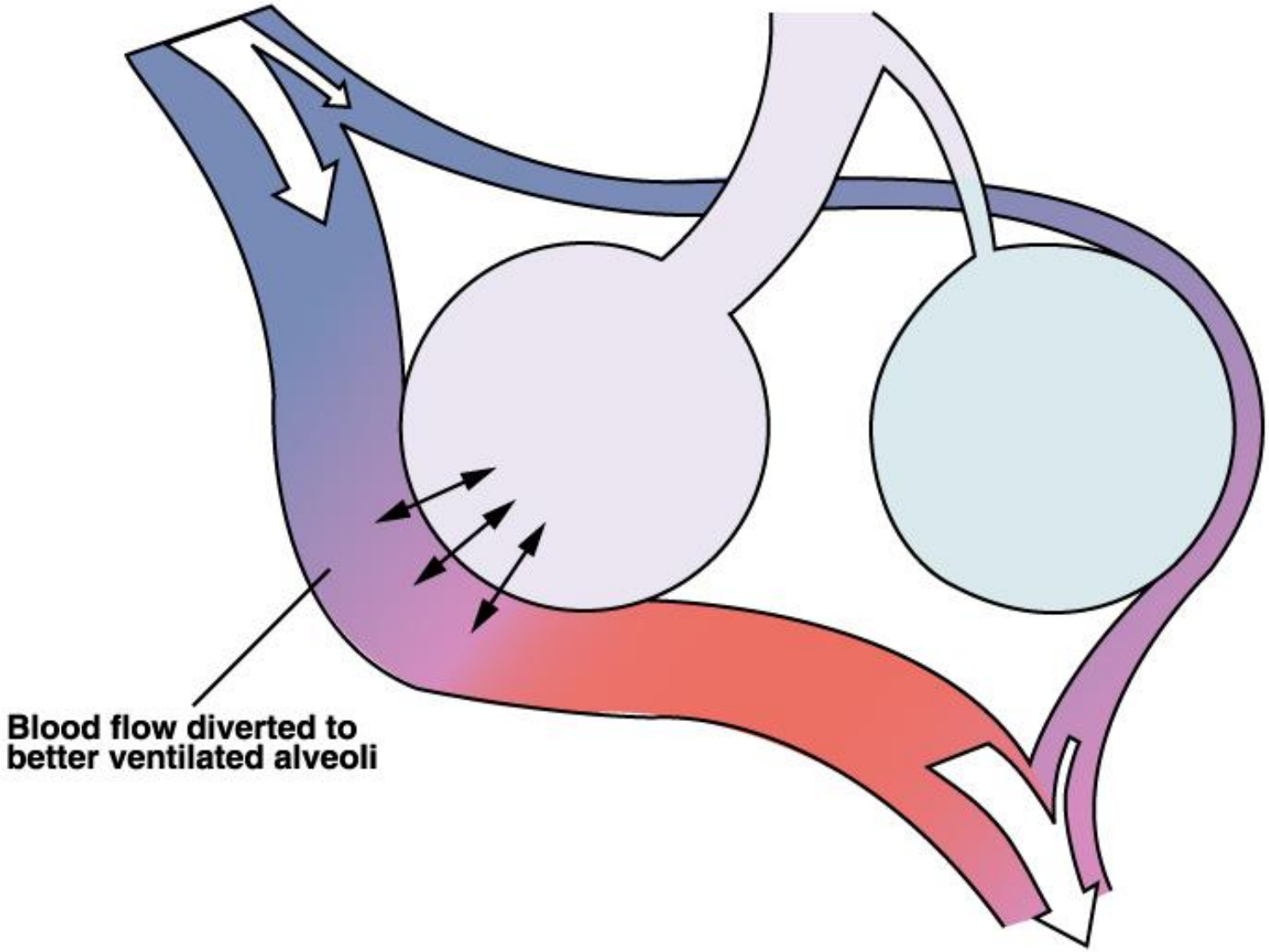
- Partial Pressure Gradients and Solubilities
- Ventilation-Perfusion Coupling
- Thickness of the Respiratory Membrane


Alveoli
P_{O_2} = 100 mm Hg
P_{CO_2} = 40 mm Hg
O_2
CO_2
P_{O_2} = 40 mm Hg
P_{CO_2} = 46 mm Hg
P_{O_2} = 40 mm Hg
P_{CO_2} = 46 mm Hg
P_{O_2} = 100 mm Hg
P_{CO_2} = 40 mm Hg
Venous circulation
Arterial circulation
P_{O_2} = 40 mm Hg
P_{CO_2} = 46 mm Hg
P_{O_2} = 100 mm Hg
P_{CO_2} = 40 mm Hg
P_{CO_2} = 40 mm Hg
P_{O_2} = 100 mm Hg
CO_2
O_2
Cells
$P_{CO_2} \geq 46$ mm Hg
$P_{O_2} \leq 40$ mm Hg
Aerobic respiration

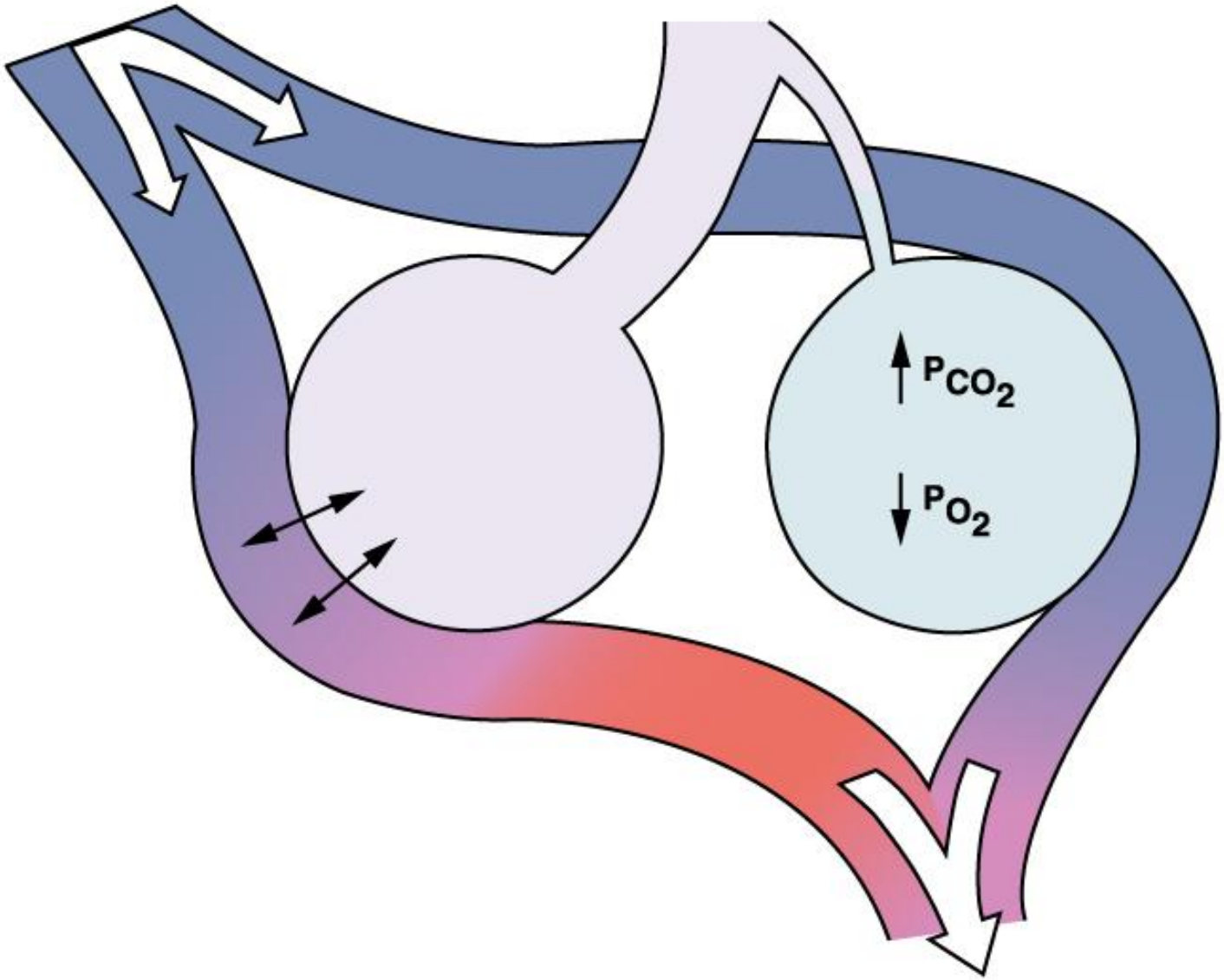
Ventilation-Perfusion Coupling



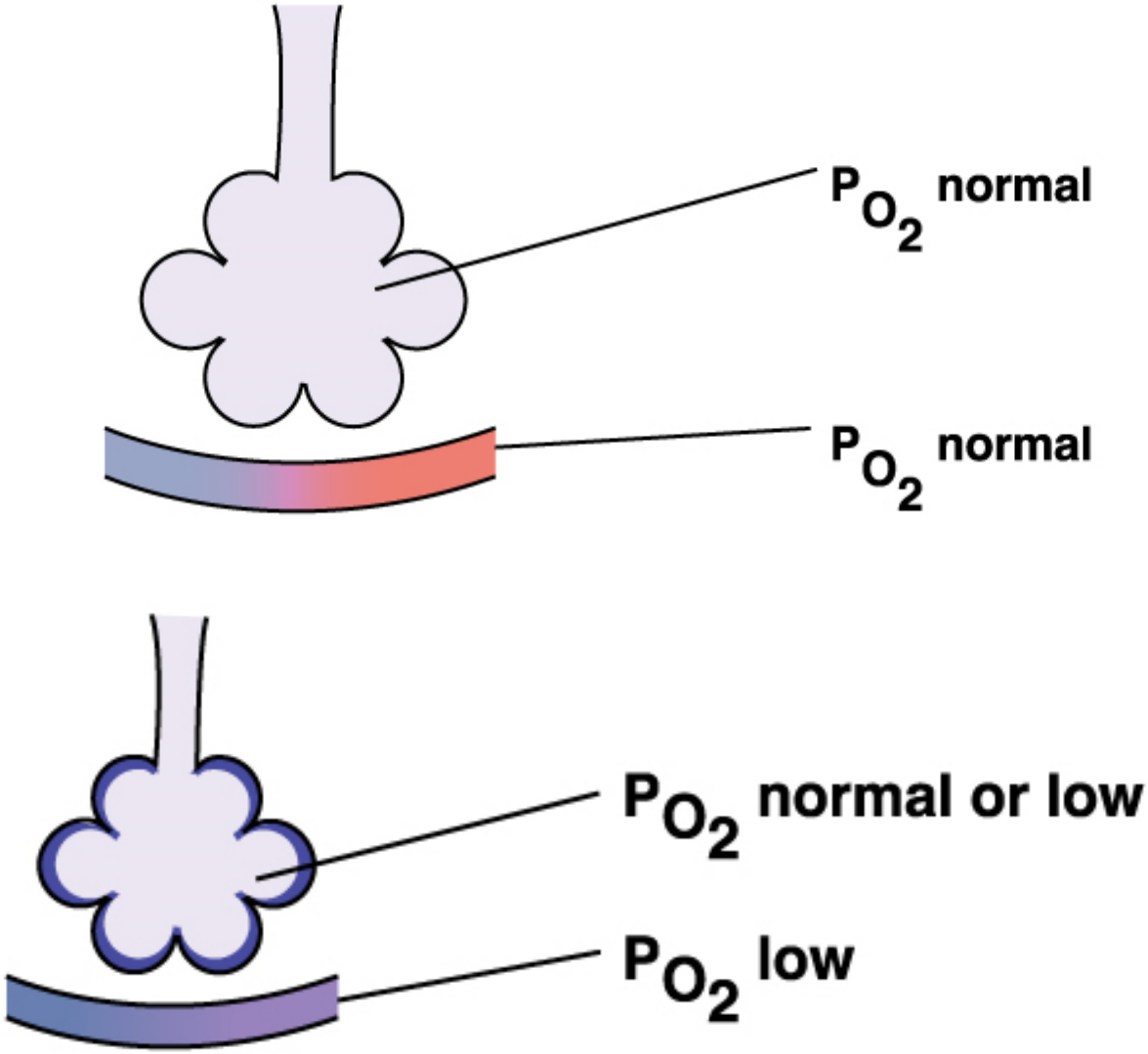
Ventilation-Perfusion Coupling



Ventilation-Perfusion Coupling



Thickness of the Respiratory Membrane



Oxygen Transport

- 1.5% dissolved in…
- 98.5% bound to...
- Oxyhemoglobin vs. reduced hemoglobin.
- *How many O_2 molecules per hemoglobin?*

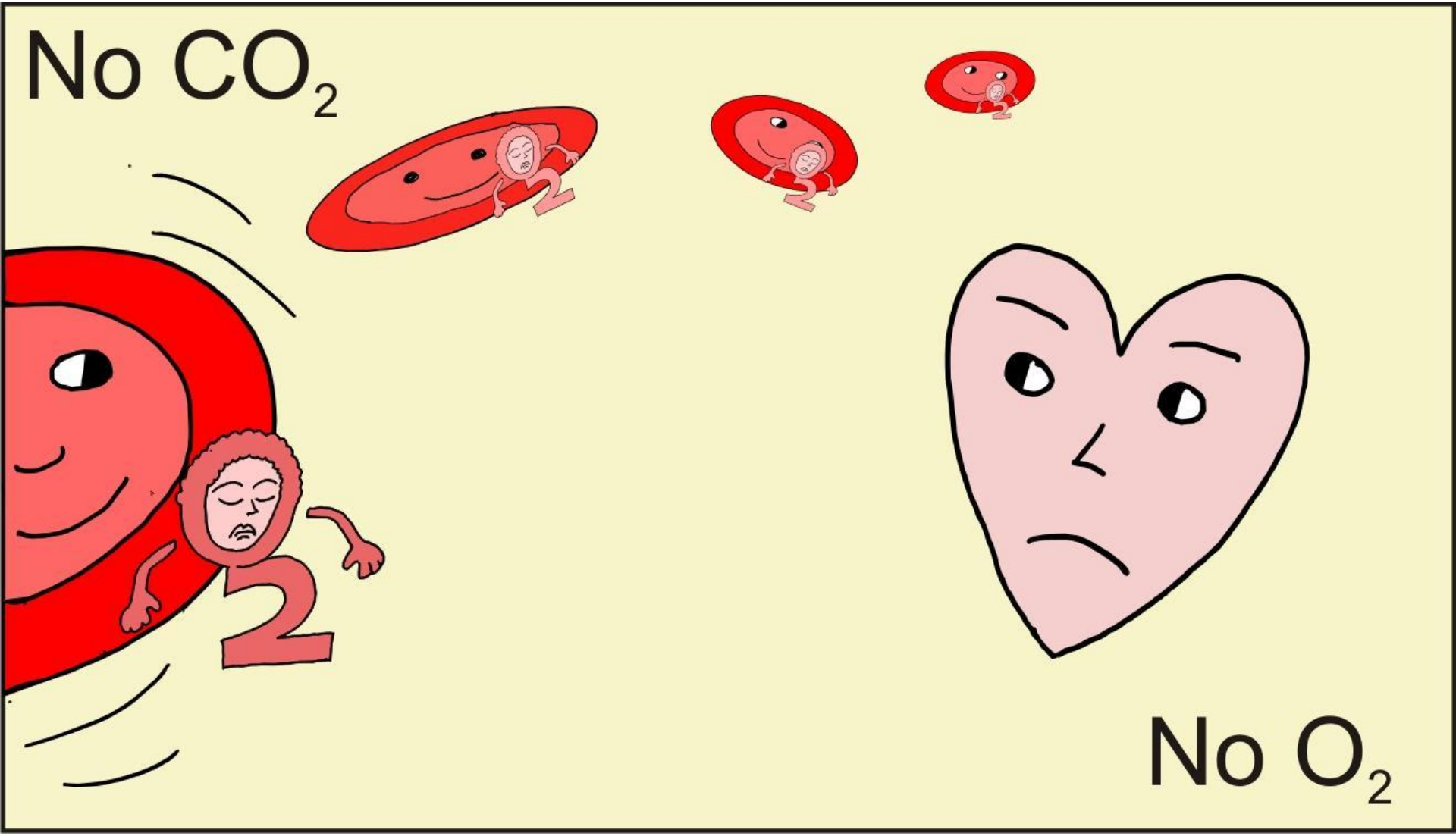
$$HHb + O_2 \leftrightarrow HbO_2 + H^+$$

Which way will the reaction go when oxygen is abundant?

Which way will the reaction go when oxygen is scarce?

What effect do carbon dioxide, heat, and low pH have on the rxn? Which way will they make it go? Why?

Bohr Effect



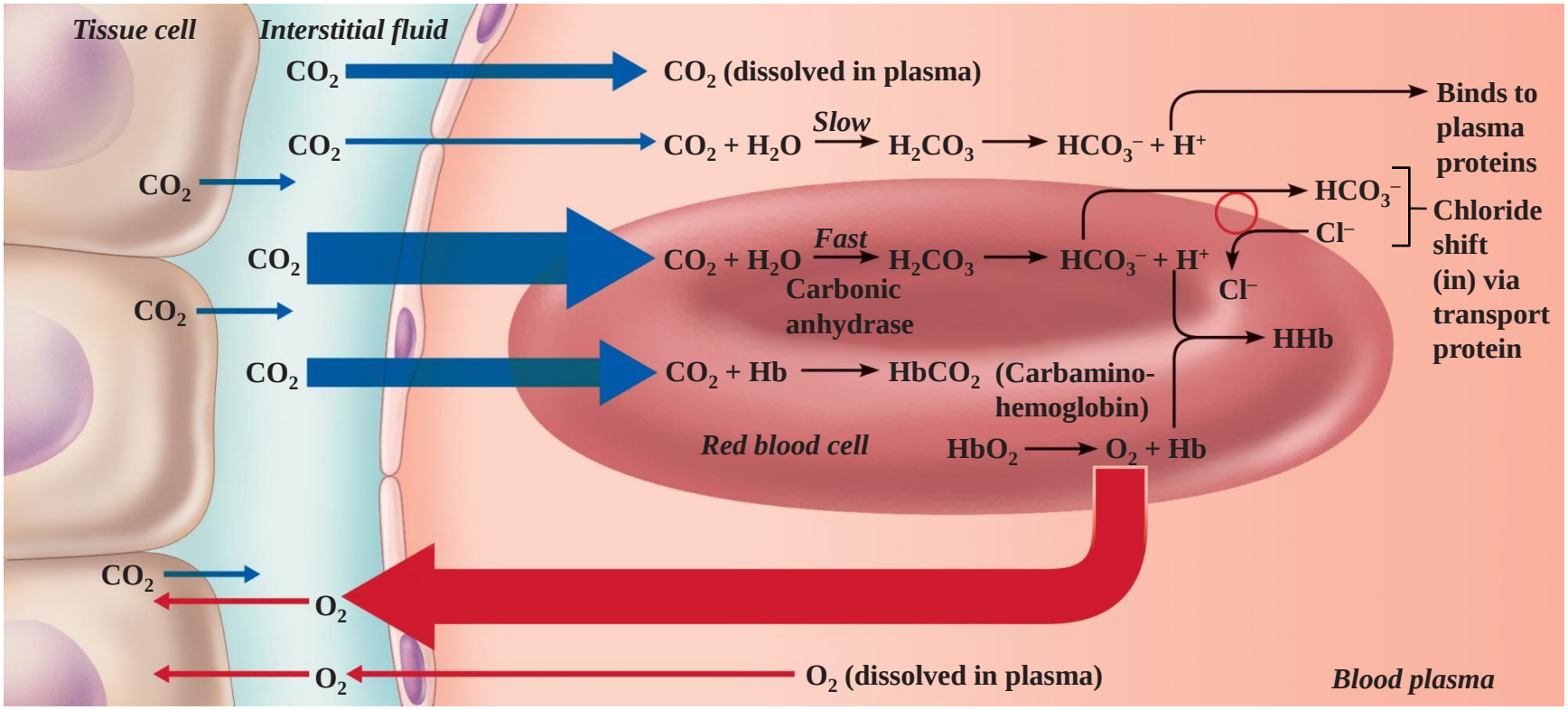
Oxygen Transport

- Levels of saturation
- Lungs
- Systemic arteries
- Systemic veins
- Venous reserve

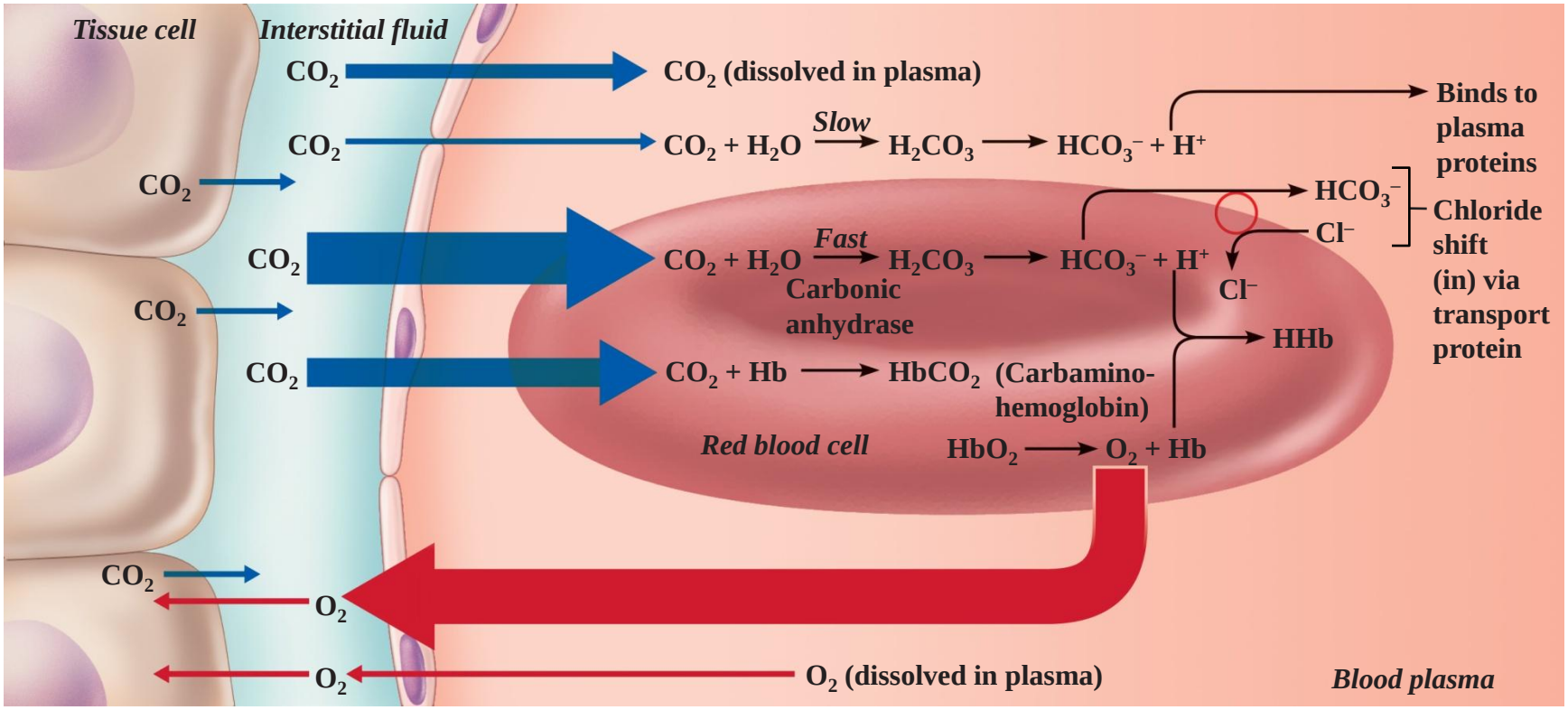
Carbon Dioxide Transport

- 10% dissolved in plasma.
- 20% as carbaminohemoglobin ($HbCO_2$) in RBCs.
- 70% as bicarbonate (HCO_3^-) in plasma.

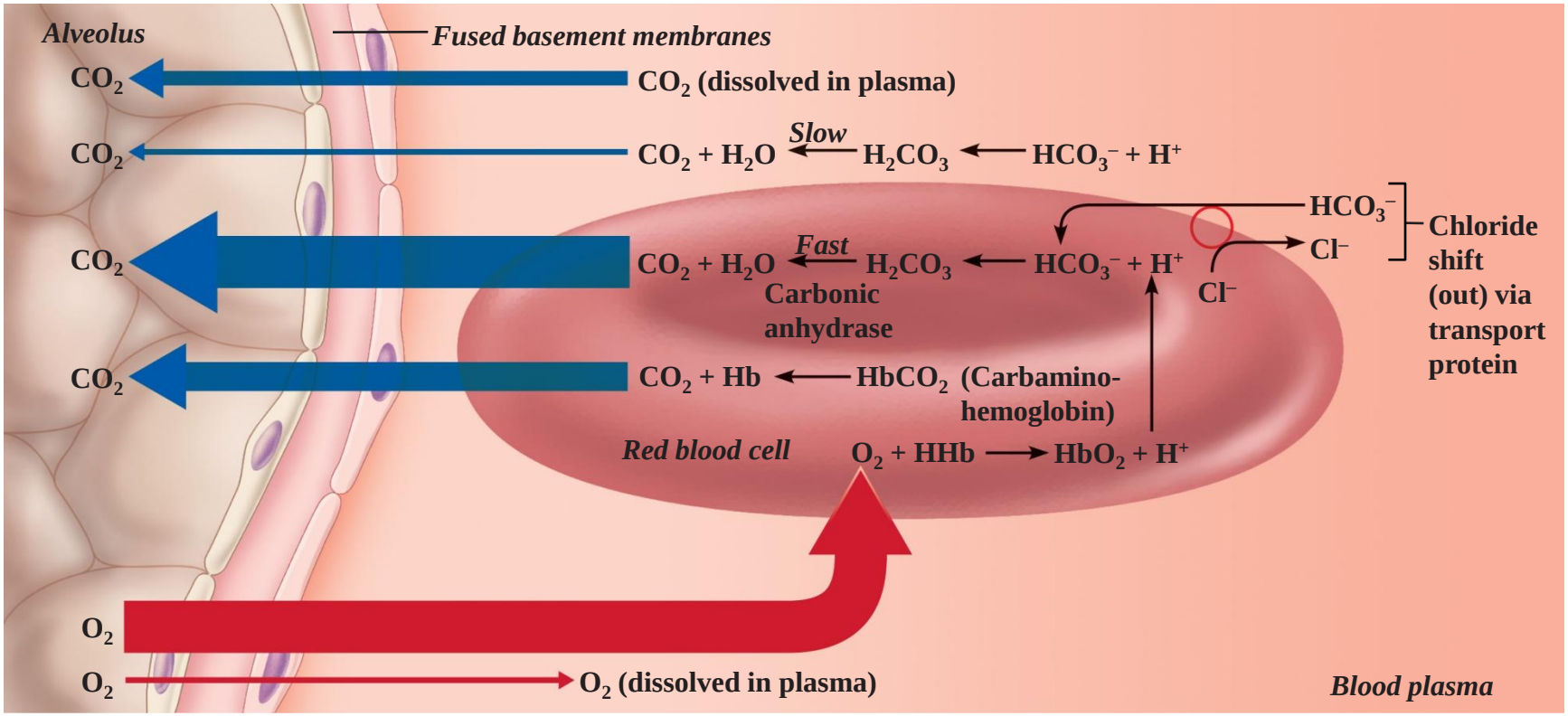
Carbon Dioxide Transport



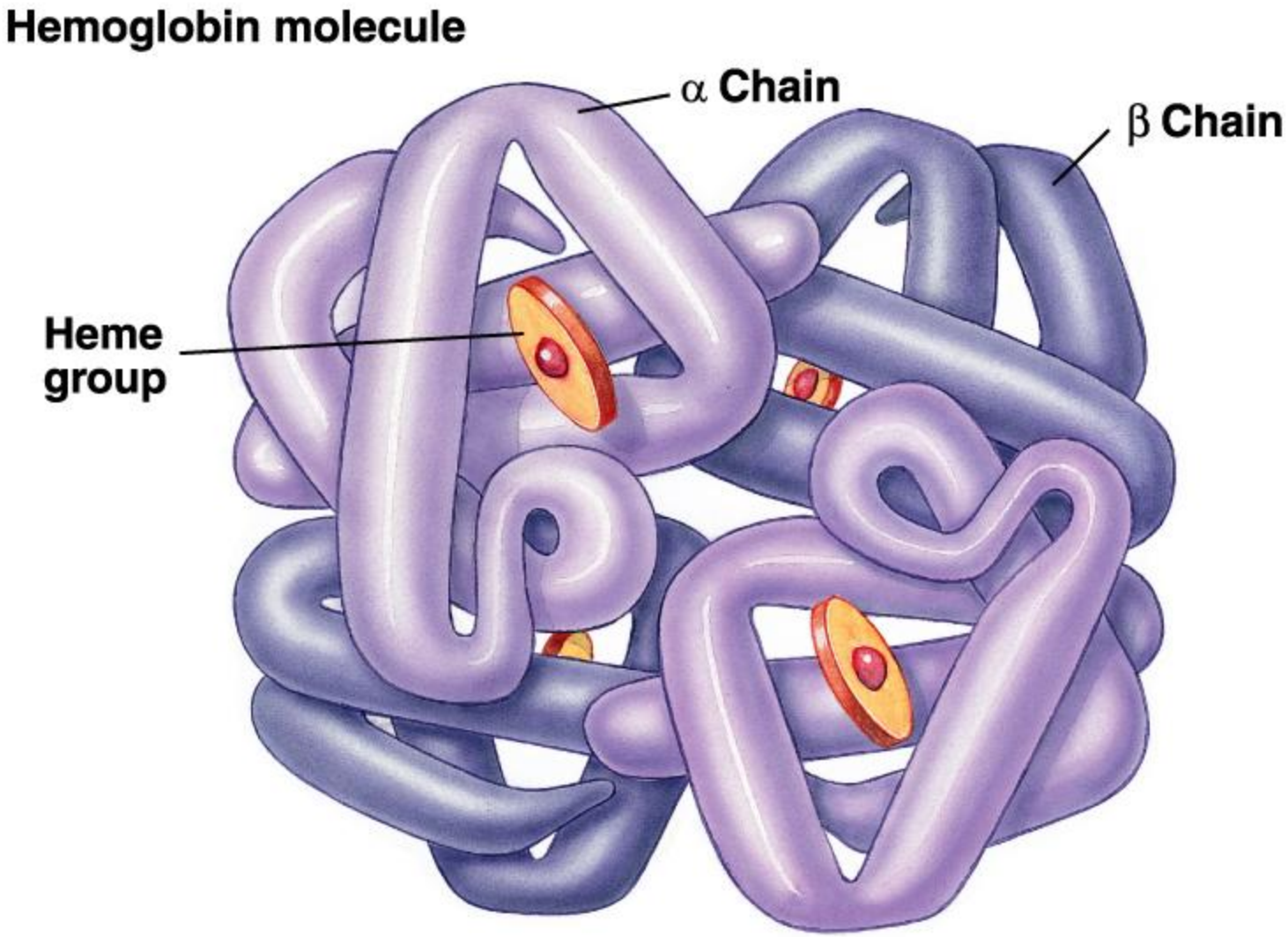
Carbon Dioxide Transport



Carbon Dioxide Transport

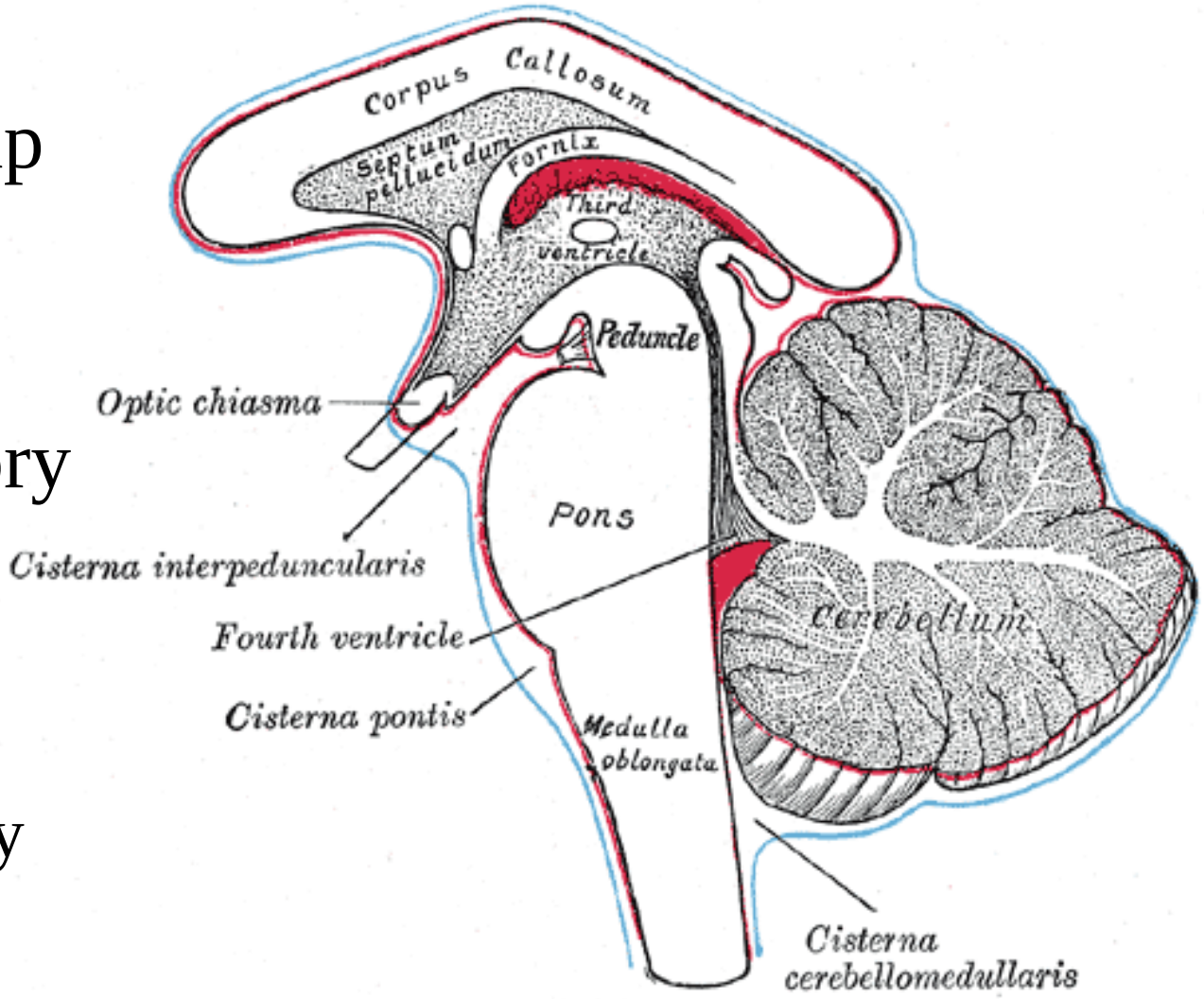


Haldane Effect



Medullary Control of Respiration

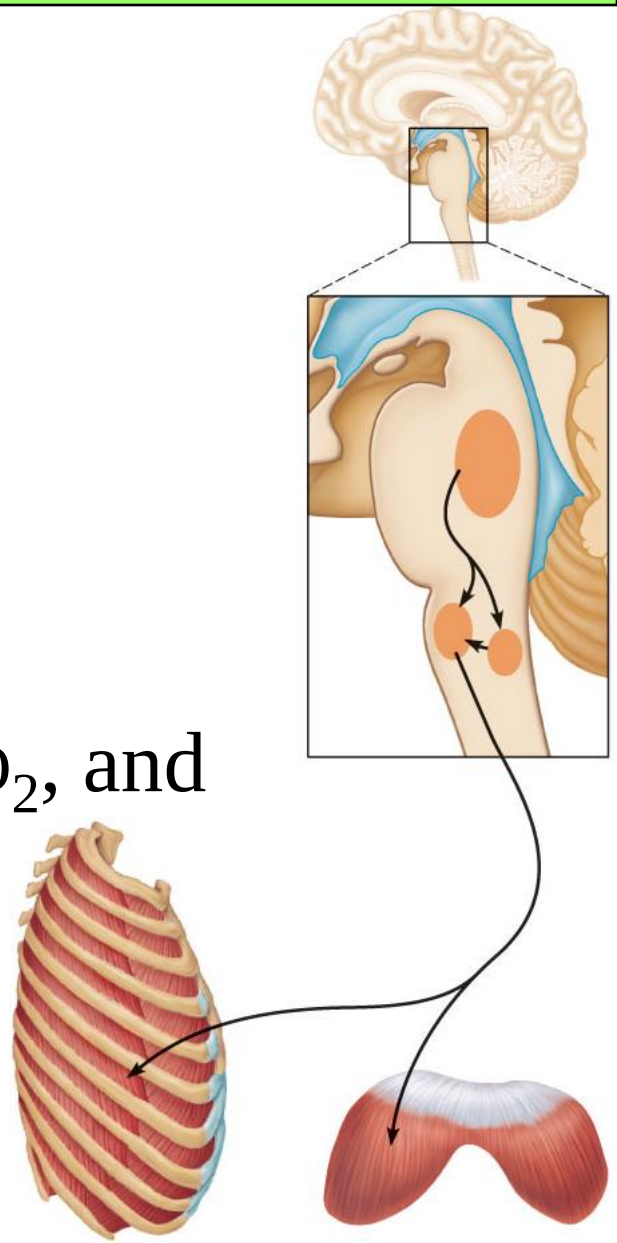
- Ventral respiratory group
- Dorsal respiratory group
- Pontine respiratory group



VRG = Primary Control Center

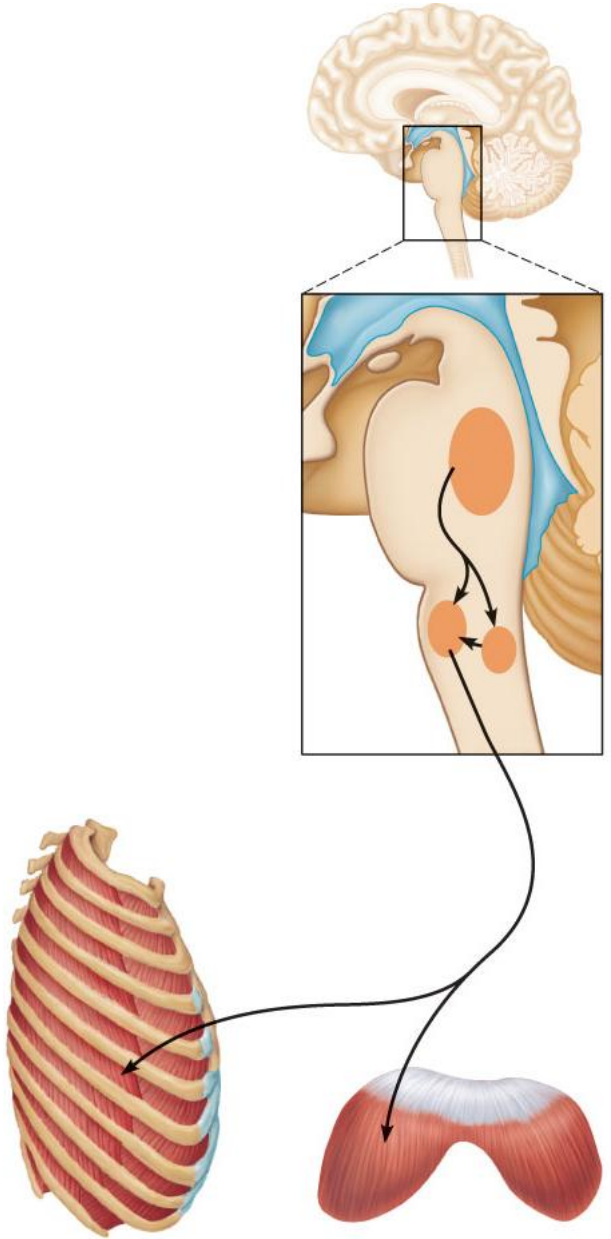
- Inspiratory neurons
  - Phrenic and intercostal nerves
- Expiratory neurons
  - Inhibition
- Mainly influenced by CSF pH
- Also influenced by plasma pH, P_{CO_2}, and plasma P_{O_2}

Eupnea



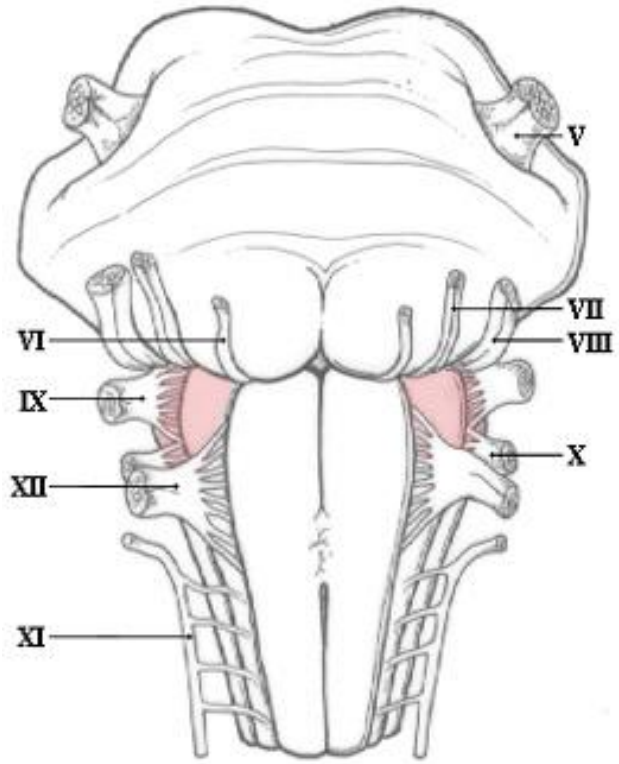
Medullary Control of Respiration

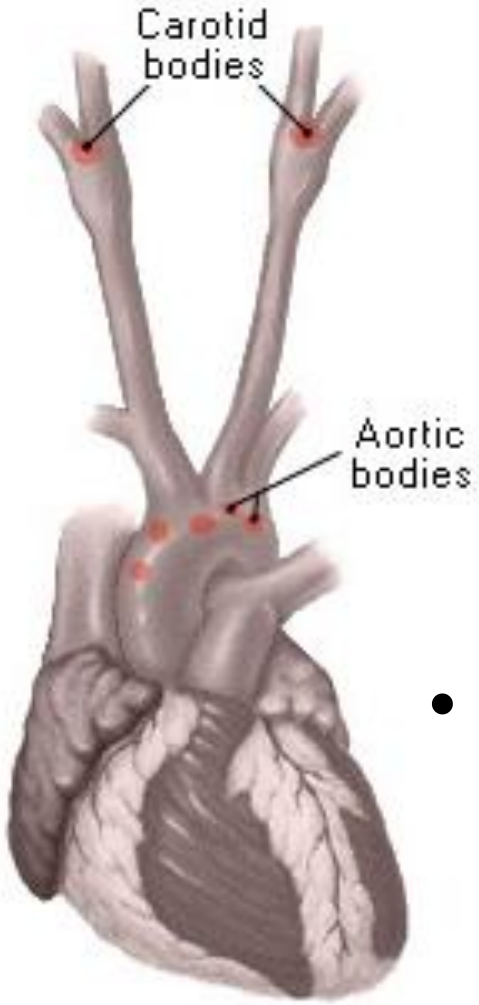
- Dorsal respiratory group
  - Helps integrate sensory info.
- Pontine respiratory group
  - Modifies breathing during sleep, exercise, etc.



Chemoreceptors

- Central chemoreceptors

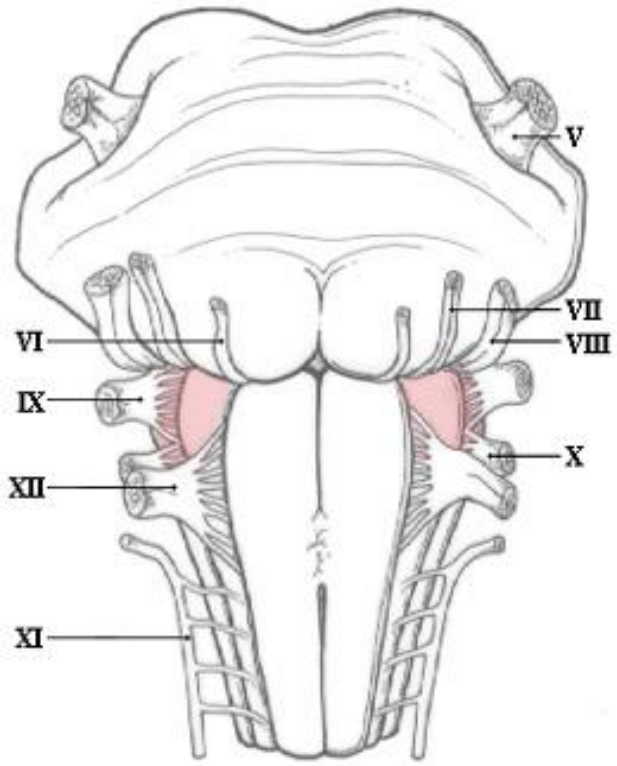




- Peripheral chemoreceptors

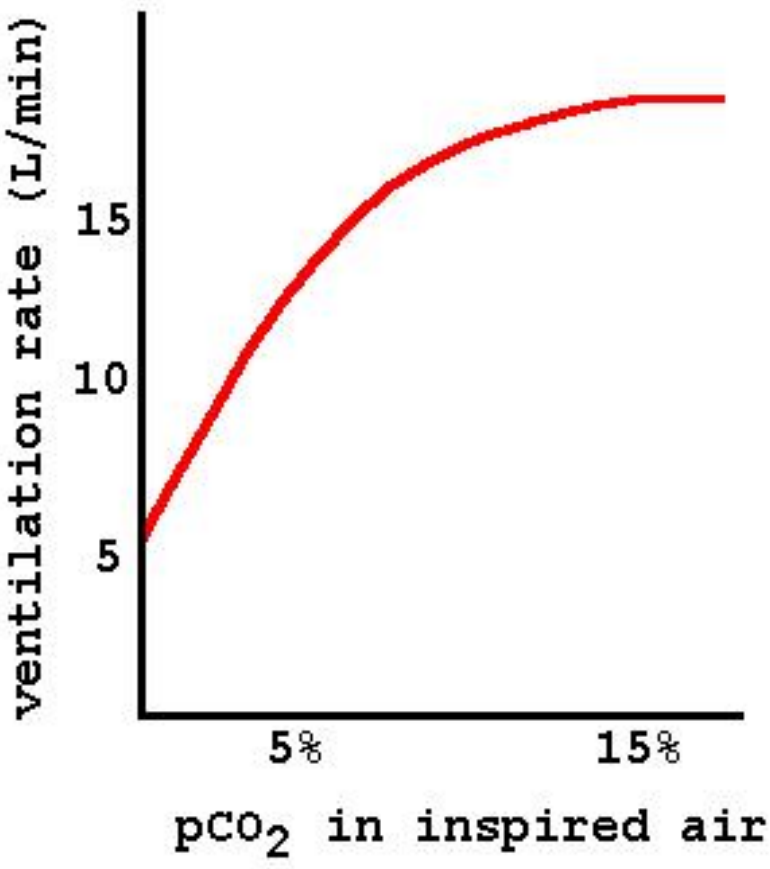
Central Chemoreceptors

- Ventral medulla
- Measure the...
- *How does CSF pH relate to CSF Pco_2*
- *How does CSF Pco_2 relate to Pco_2?*



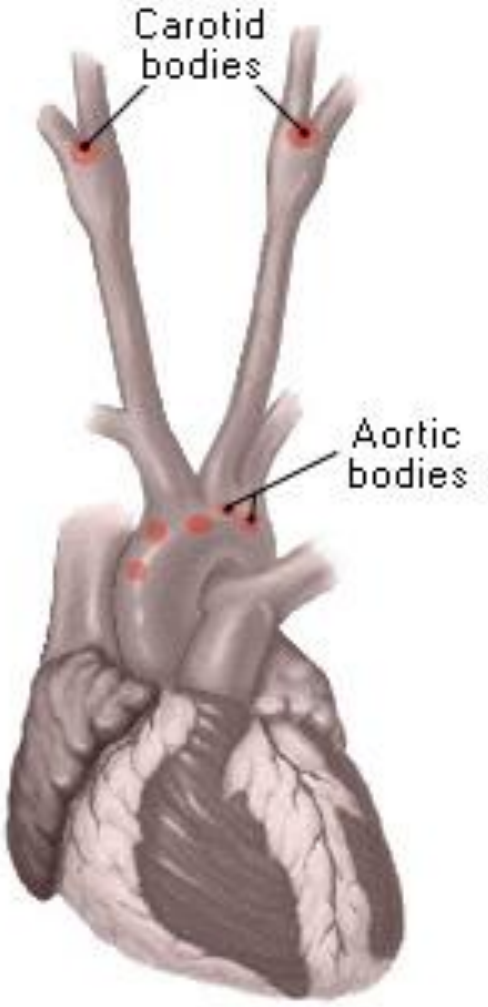
An increase in plasma CO_2 will cause…

- *Plasma Pco_2 to:*
- *CSF Pco_2 to:*
- *CSF H^+ to:*
- *CSF pH to:*
- *Respiration rate to:*
- *Respiration depth to:*



Peripheral Chemoreceptors

- Aortic arch and carotid sinuses
- Measure plasma…
- Less sensitive

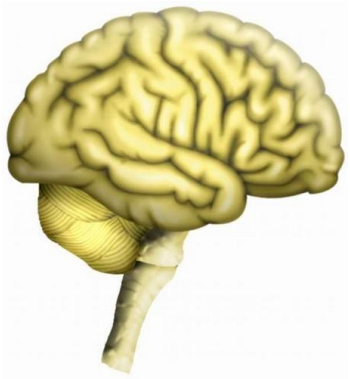


Secondary Factors Influencing Respiratory Rate

- Temperature

- Blood pressure

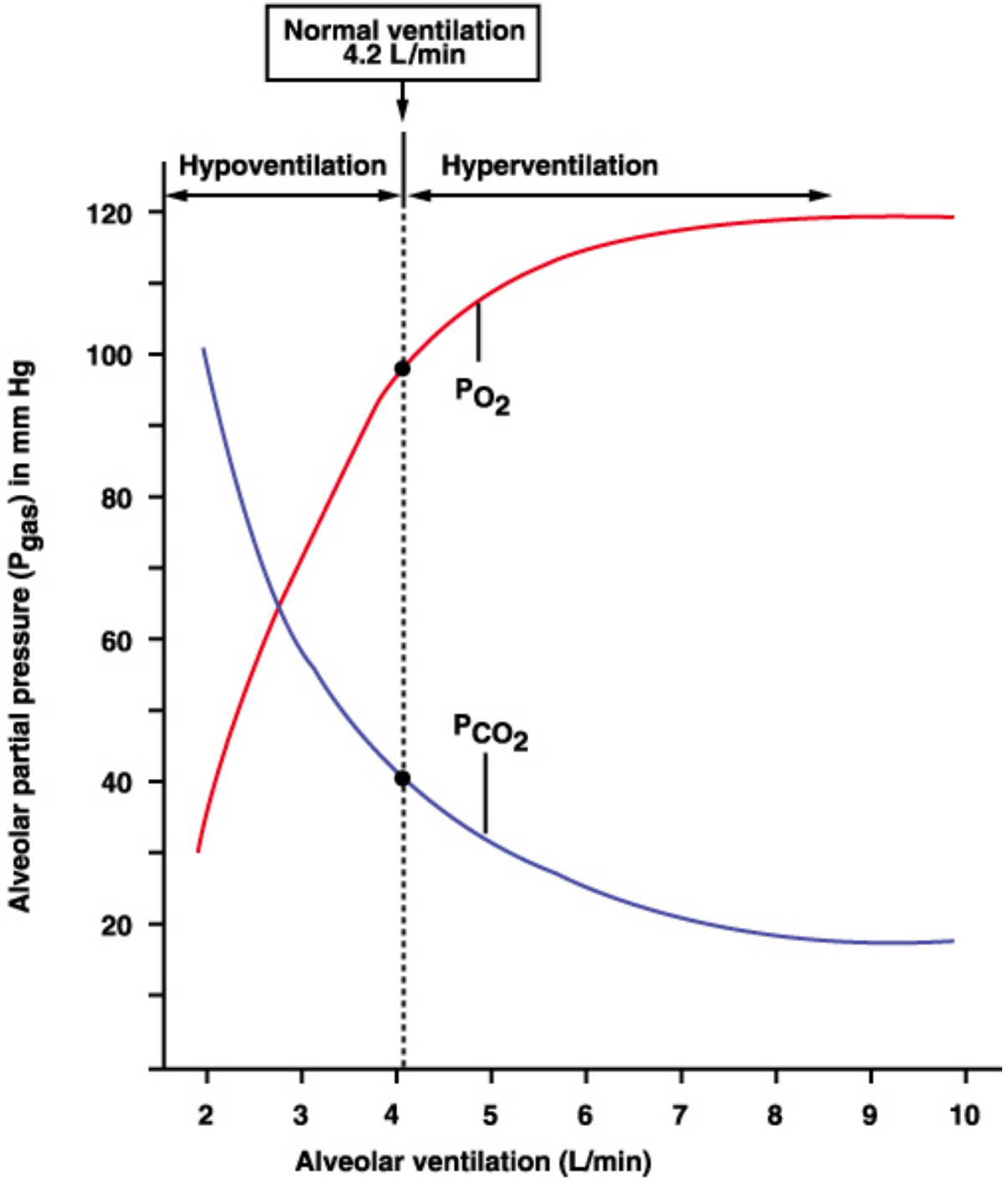
- Cerebral cortex



Secondary Factors Influencing Respiratory Rate

- Irritants.

- Inflation reflex.


Normal ventilation
4.2 L/min
Hypoventilation
Hyperventilation
120
100
80
60
40
20
P_{O_2}
P_{CO_2}
Alveolar partial pressure (P_{gas}) in mm Hg
2
3
4
5
6
7
8
9
10
Alveolar ventilation (L/min)

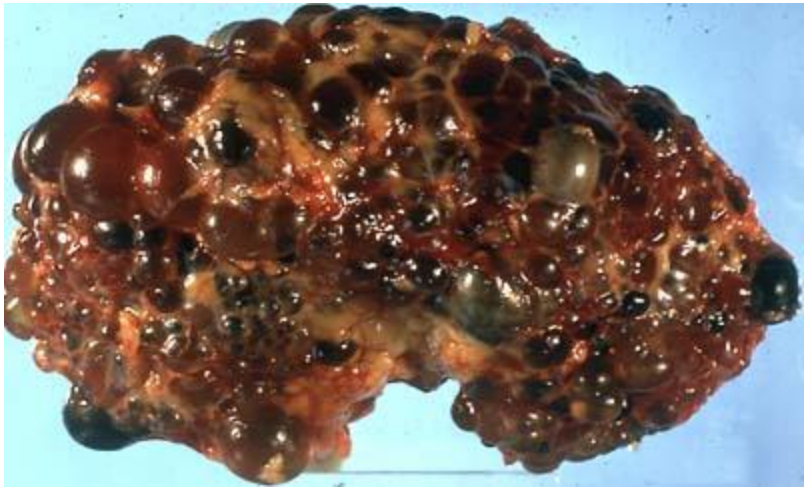
Respiratory Acidosis and Alkalosis

- *Hypoventilation would have what effect on plasma pH?*

- *Hyperventilation would have what effect on plasma pH?*

Metabolic Acidosis

- *What happens to plasma pH?*
- *What are possible causes?*
- *How would the respiratory system attempt to compensate?*



Metabolic Alkalosis

- *What happens to plasma pH?*
- *What are possible causes?*
- *How would the respiratory system attempt to compensate?*